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A Theory for Enquiry in Design PhD Research¹

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Design PhD research commonly faces conflicting criteria between doing justice to designing (from, systemically speaking, subjective inside perspectives) and doing justice to academic research (subject, systemically speaking, to scrutiny by objective outside criteria). The theory of enquiry presented here takes a cybernetic approach to distinguish different concerns and criteria of design research with reference to applicable systemic boundaries. It aims to facilitate the understanding of and to offer provide strategic risk management guidance for design research enquiries in the presence of conflicts between these concerns and criteria.

KEYWORDS: epistemology, cybernetics, design PhD research, science, design

RSD TOPIC(S): Learning & Education, Methods & Methodology

¹ This is a modified and developed version of a previous publication (Fischer, 2019), aimed to further expose the described ideas to their intended audiences here.

Presentation: “uncomfortable marriages”

The PhD is an academic research degree. Accordingly, PhD students are expected—and generally aspire—to demonstrate the capability to conduct independent academic research. Academic research, meanwhile, is predominantly understood to be grounded in the natural-scientific paradigm. Based on this understanding, PhD research work is expected to apply scientific methods and result in original, explicit, and reliable contributions to knowledge.

The design discipline, however, has its primary roots in professional and artistic contexts, and it inherited the bulk of its concerns and values from there. While design shares some academic concerns and values (such as the striving for originality and the reliance on adversarial argument and debate to assure quality), it does not share all of them.

Various authors have contrasted scientific and designerly concerns previously. Simon (1996, pp. 114) notes that “The natural sciences are concerned with how things are. [...] Design [...] is concerned with how things ought to be, with devising artefacts to attain goals”. Buchanan (1992, p. 17) elaborates: “scientists are concerned with understanding the universal properties of what is, while designers are concerned with conceiving and planning a particular that does to yet exist”. Krippendorff (2007, p. 73) observes: “Whereas scientific researchers seek knowledge for its own sake, value-free, and without regard to their utility, designers value knowledge that improves the world, at least in the dimensions related to their designs.” Table 1 below lists several distinguishing concerns and values of natural science and design alongside some related references.

Table 1: Some distinguishing characteristics of natural science and design.

Academic research grounded in natural science	Design rooted in professional and artistic practice	References
objective measurement	subjective appreciation	Fischer (2008)
observable evidence	internal pondering/inspiration	Fischer (2008)
generalisability	attention to particulars	Buchanan (1992), p. 17
repeatability/predictability	spontaneity in the design process, reliability in design products	Fischer (2017)
truth, correctness	appropriateness/viability	Rittel and Webber (1973, pp. 162–163)
knowledge of	knowledge for	Glanville (2019, p. 59)
efficient causality (because-of); descriptive ends	final causality (in-order-to) to; normative ends	Simon (1996, pp. 114); Schurz (1997); Fischer (2009, p. 793)
rigor; doing things right	relevance; doing the right thing	Schön (1985, p. 15–20); Bennis and Nanus (2003, p. 20)
testing of hypotheses	reflective practice	Schön (1985)
conclusive results	perpetual search	Glanville (2019), p. 53
explicit description/ explanation	tacit knowing	Polanyi, Michael (1967); Schön (1985), pp. 21–23.
avoidance of error, risk and ambiguity	openness for error, risk and ambiguity in the design process	Herr and Fischer (2019a), pp. 544–545.

Given these conflicting concerns and values, academic design research faces a potential for inherent inconsistency. Accordingly, the relationship between academic research and design has been likened to “sometimes uncomfortable marriages” (Glanville, 2014c). Krippendorff (2007) calls the fundamental compatibility of both fields into question and asks whether the term design research itself is an oxymoron.

The relationship between design and academic research has furthermore been portrayed differently over time and from different perspectives. Simon (1996, pp. 112–113) characterises research in the context of design as “intellectually soft, intuitive, informal, and cookbooky” and essentially deficient until it adopts an “intellectually tough, analytic, partly formalizable, partly empirical, teachable doctrine about the design process”. This call for design research to assume a proper academic research attitude posits design research as a subset of the greater academic research enterprise, corresponding to the way design schools are accommodated among other departments forming sub-institutions within larger academic organisations. Archer (1979) and Cross (1982, p. 221) describe design and science as co-existing separately, whereas Jones (1992, p. 10) describes design as a hybrid of science, mathematics and the arts. Farrell and Hooker (2012) argue that science and design are “not different in kind” – a view subsequently disputed by Galle and Kroes (2014). Glanville (1999, p. 89; 2019, p. 34) then inverts Simon’s view and argues that “scientific research is a subset of design, not the other way round”.

Risk management

Any research that seeks to satisfy criteria of multiple, mutually contradictory value systems at once is vulnerable to challenge or rejection on grounds of one or more of the invoked value systems or based on inconsistencies between them. Design PhD research can thus – given the conflicts outlined above – be vulnerable to relatively simple exam questions, such as

- “I do not see any design here. Why is this kind of work be undertaken at a design school?”
- “You are making subjective and non-falsifiable arguments. Why should this warrant the bestowal of an advanced academic degree?”

- “Are you taking a descriptive approach or a normative approach? You cannot take both!”

Such vulnerabilities entail the risk of challenge or rejection, the probability of which varies between institutions, depending on their respective research cultures and procedural guardrails. The impact of the challenge or rejection of research, in turn, depends on institutional and personal investments. As these investments are rather high at the PhD level, doctoral design students and their supervisors bear the brunt of the risk in academic design research. It can be argued, of course, that the development of risk management skills is a part of PhD education and that risk is, therefore, a necessity in this context. This view, obvious as it may seem from academic perspectives, may not fully appreciate the discrepancy between the levels of risk involved in PhD design research on the one hand and design students’ preparedness to manage risk cautiously on the other hand. Having been encouraged to develop considerable risk appetites in their undergraduate and graduate studios, the need to then approach risk cautiously in their doctoral studies can place PhD design researchers in challenging double binds (Bateson, 1987, pp. 156–157). This state of affairs necessitates explicit risk treatment strategies. The full range of such strategies (Whitman and Mattord, 2019, p. 368) may be considered.

Termination: Discontinuance of the design PhD project. This amounts (from the candidates’, the supervisors’ and from the host institutions’ perspectives) to “not obtaining the degree” with the added disgrace of surrender. Accordingly, this strategy may appear worse than a failed thesis defence and continued project pursuit, even against great odds, may appear to be the better option. Considering the possible damages that the insistent pursuit of challenging projects can inflict on mental health, family life etc., however, termination may, in some cases, be a prudent choice.

Transference: Delegation of risk to third parties. The delegation of research and writing responsibilities to others constitutes plagiarism and is unacceptable in academic contexts. Some forms of risk transference, however, are both acceptable and common in academic design research. Using theoretical frameworks or research methods proposed by others instead of devising original ones, for example, can shift the burden of justification to those third parties.

Acceptance: Understanding the potential vulnerabilities of academic design research and resolving to absorb the possible consequences of challenge or failure. Given the aforementioned personal and institutional investments at the PhD level and the availability of alternative risk treatment strategies, this is not the best way to treat substantial risk in this context.

Mitigation: Reducing the impact of successful challenges or rejection of design research work. This strategy is pursued more commonly at the institutional level than at the project level. Examples include internal progress reviews of ongoing PhD projects at regular intervals, the possibility to revise and re-submit theses following unsuccessful defences, and the bestowal of MPhil degrees for terminated PhD projects.

Defence: The term defence carries diverging meanings in the contexts of risk management and higher education. In risk management terms, defence can refer to the minimisation of vulnerabilities and their exposure, i.e., risk avoidance. In academic design research, this is the case where research is set up to satisfy academic criteria alone while leaving design criteria out of the equation. Examples include historical research into design artefacts or physics-based research into the performance of design outcomes. Another form of risk avoidance in PhD studies is the reduction of the likelihood of successful challenge or rejection, for example, by recommending and appointing well-disposed examiners. In the context of both risk management and higher education, the term defence also refers to the prevention of successful attacks by way of removing vulnerabilities and taking protective and strengthening measures. In design PhD research, this may include the strengthening of methodological and narrative structures in response to weaknesses detected through self-scrutiny or mock exams.

The theory for enquiry developed in the following aims to guide defensive risk mitigation in this latter sense. It develops a vocabulary for project teams to coordinate and strategise – and to conduct enquiries combining different kinds on their respective terms by concatenating and nesting them.

Development of the theory

The theory for enquiry presented in the following is developed from a predominantly cybernetic perspective.² It is, for the most part, an amalgamation of categorisations and models proposed previously by others, in particular by Christopher Frayling, Ranulph Glanville, Robert Rosen, and Stuart Umpleby. This section outlines how these various contributions relate to each other and constitute the proposed theory. It unfolds in a conceptual space opened up between three categories of design research proposed by Frayling (1993/1994, p. 5) and further discussed by Findeli (1999, p. 2) and Downton (2003, p. 2): research for design, research into/about design, and research through design. Findeli (1999, p. 2) describes research for design as best exemplified by “R&D” – research and development work – in support of design. He describes research into/about design as “carried out under the heading of other disciplines (sociology, semiotics, economics, history, etc. ...) of design”. Concerned with evidence-based description, research into/about design takes an empiricist approach to the processes and outcomes of design. Frayling (1993/1994, p. 5) describes research through design as “being achieved and communicated through the activities of [...] design”. Findeli (1999, p. 2) relates the latter to what has also been referred to as “action research by project”, “project-grounded research”, and “practice-led research” (see Hohl, 2019, pp. 23–25).

I (Fischer, 2011, p. 629; 2017, p. 1594) noted previously that Frayling’s (1993/1994) design research trichotomy maps onto a diagrammatic model (Figure 1) that has been referred to in the cybernetic discourse on some occasions (Umpleby, 2007; von Foerster, 1971), the so-called epistemological triangle with roots, according to Glanville (1975, p. 192), in the work of Frege.³ The vertices of this triangle correspond to the describer, i.e. observers including you and me, the described, i.e. the observed world, and descriptions, i.e. describers’ accounts of observations (see Maturana and Varela, 1980, p. 8).

² Detailed descriptions of the relationship between design (research) and cybernetics can be found in Glanville (2014) and Sweeting (2017).

³ Ogden and Richards (1989) propose the similar “triangle of reference”, and Popper’s (1978) “three worlds” follow along similar lines.

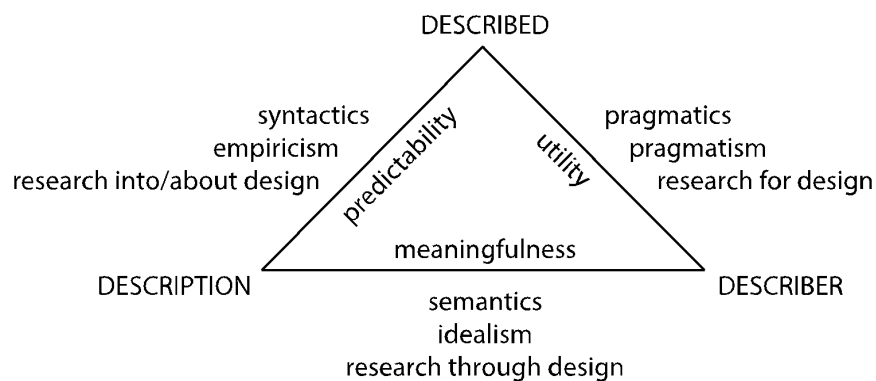


Figure 1. Epistemic triangle and associated concerns.

Since none of these three elements can be conceived of independently from the remaining two, their separation in the diagram is somewhat contrived. Ignoring the entanglement of the three elements in subjective experience and allowing structured analysis, this reductionist move of gaining the advantage of clarity at the expense of fractured and selective views is fundamental to empirical science. It is itself depicted in the diagram as the separation of description from described. This separation is, in turn, reflected in the etymology of the word “science”, whose Indo-European root “skei” refers to activities such as separating, distinguishing or taking apart, and also forms the basis of the words scissors, schism and schizophrenia (Bröcker, 2004; Fischer, 2011, p. 629).

In response to von Foerster (1971), Umpleby (2007, p. 4) points out that the three edges of the epistemological triangle correspond – besides the linguistic approaches syntactics, pragmatics and semantics – to the science-philosophical perspectives of (British-originated) empiricism between description and described, (US-originated) pragmatism between describer and described, and (continental European-originated) idealism between description and describer. Each of these perspectives attends to one of the three relationships that make up the triangle while downplaying the remaining opposite vertex. Empiricism downplays the observing describer and establishes

“objective” descriptions of the observable world. The essential evaluation criterion for research along this edge is formal correspondence (or, in short, form), affording predictability. Pragmatism downplays description to establish workable ways for observers to operate in the world. The essential evaluation criterion for research along this edge, therefore, is utility. Idealism, finally, downplays the observer-independent world and establishes descriptions of explanatory value to describers. The essential evaluation criterion for research along this edge is meaningfulness.

Once any one of the three vertices of the epistemological triangle is downplayed and neglected, the relationship between the two elements remaining in focus may be examined. Every one of these three relationships is, I argue, circularly-causal in nature. Describers affect the described, and the described affects describers. Describers affect descriptions, and descriptions affect describers. The described affects descriptions, which, in turn, deployed for prediction and control, affect the described. The latter relationship lies at the heart of empirical science (where the circular nature of this relationship remains largely ignored). It has been captured in the Modelling Relation by cybernetician Rosen (1999, p. 159), which is depicted in Figure 2.

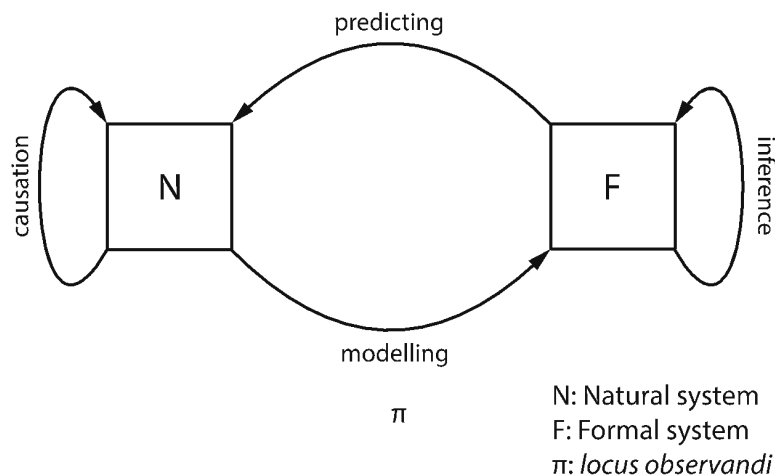


Figure 2. Modelling relation based on Rosen (1999, p.159).

This figure corresponds to the edge connecting described and description in the epistemological triangle. In Rosen's nomenclature, this is the relationship between a "natural system" N and a "formal system" F. The empirical investigator observes N, and devises F, hypothesising that, and testing whether F "is like" N.⁴ To qualify for entry into this relation, Rosen points out, N must display causal connections. F, in turn, qualifies for entry into this relation by allowing inferences and predictive statements about not-yet-made observations of N to some satisfactory degree of reliability.

For the remaining two circularly-causal relationships in the epistemological triangle – both of which involve the subjective describer/observer – I propose an adaptation of Rosen's Modelling Relation, which reflects Glanville's design cybernetics. This structure, depicted in Figure 3, shows a self S relating to an other O according to Glanville's characterisation of design as conversation (Glanville, 2014)) between (in the most simple scenario) a self and an other. Living as well as non-living entities qualify for entry into this relationship as an other by exhibiting patterns. Understanding such patterns permits reflection within self, allowing self in turn to better act vis-à-vis the other. Understanding and acting better over time, along these two arcs, both requires knowledge for, and produces knowledge of respectively (Glanville, 2014c, p. 17), and thus entails efficient as well as final causality (Segal, 2001, pp. 44–47).

⁴ This is how I understand Gordon Pask's (1975, p. 13) definition of cybernetics as "the science or the art of manipulating defensible metaphors; showing how they may be constructed and what can be inferred as a result of their existence."

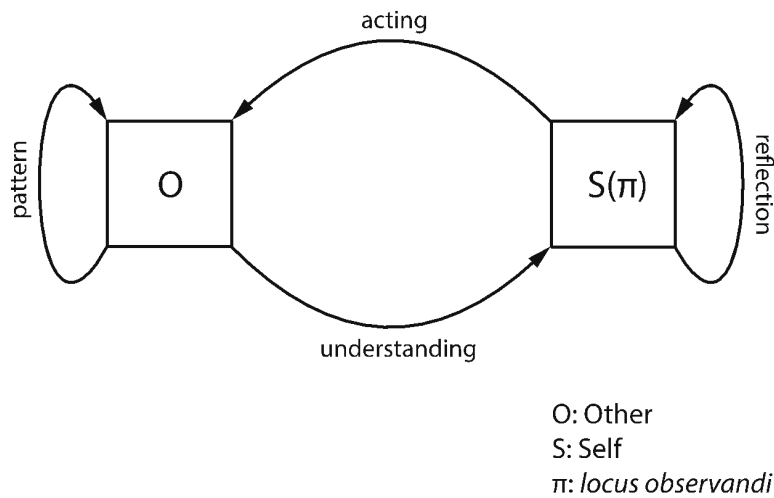


Figure 3. Glanville's design conversation, illustration based on Glanville (2014).

The feedback relationship between self and other depicted in Figure 3 differs from technical feedback loops such as thermostats (see Glanville, 2014a, p. 5) with regards to the roles played by variety. In technical control relationships, on the one hand, error and noise are minimised and avoided so as to maintain requisite variety. The thermostat, with an equal and constant number of states (on and off) in both sensor and heat source, satisfies Glanville's Corollary of Ashby's Law of Requisite Variety (Fischer, 2019b) and thereby ensures effective control. The epistemic relationship between self and other, on the other hand, is characterised by the continual renegotiation of variety on either side. Design-conversational loops harness mistakes, misunderstanding and serendipity, seeking to change (to amplify or to reduce) variety to get out of control and thereby arrive at the previously unknown. The varieties at play in the exchange are subject to the exchange itself.

Figure 3 depicts epistemic practice as done, i.e. what is meant here by the term "enquiry". Figure 2 depicts the structure of outcomes of empirical enquiries. Despite their similarities, these two structures differ in regard to the disposition of the observer indicated with the symbol π . In Figure 2, π is located outside of the loop of enquiry to signify an external locus *observandi*, complying with the scientific requirement of objectivity. In Figure 3, π is located at the position of the self to signify the self's

subjective locus *observandi*, as it is characteristic of action-based epistemic activities such as design.

Where designerly modes of enquiry are not tolerated and face academic scrutiny, PhD researchers may be well advised to commit, from early on, to work towards a defence on “robust” empirical grounds. For this purpose, as will be explained below, idealist and pragmatist design enquiries can be nested within empiricist research into/about designing. In this way, enquiries corresponding to Figure 2 and enquiries corresponding to Figure 3 can be combined, allowing design researchers to do justice to both.

Understanding cybernetics as the study of processes in which states of affairs are adjusted with reference to other states of affairs and understanding systems as sets of elements with a shared goal contained within observer-projected boundaries (Fischer and Richards, 2017, p. 37) yields four possible dispositions (i.e., combinations of locations of observers and references relative to the boundaries of systems) (Glanville, 1997, appendix; Glanville 2019, p. 52). These dispositions map onto Frayling’s (1993/1994) design research trichotomy, extended by Jonas,⁵ as follows:

- the observer is inside, looking outwards: research through design
- the observer is outside, looking inwards: research into/about design
- the observer is outside, looking outwards: research for design
- the observer is inside, looking inwards: research as design

These dispositions differ with regards to where investigators (observers: designers, researchers) position themselves relative to the boundaries of a given enquiry, and whether references (criteria, standards, goals) relevant to these enquiries are located within or beyond these boundaries. Where design research is to do justice to design and to be defended against academic (formal) scrutiny, as is the case in some design PhD enquiries, investigators must navigate with both internal references (say aesthetic or ethical aspirations) and external references (scientific standards). Designers are no

⁵ In my 2007 thesis, I relate three of these dispositions to Frayling’s three categories of design research (Fischer, 2008, pp. 214–215); see also: (Fischer, 2011, p. 629; 2017, p. 1594). Having examined my thesis, Jonas (Chow and Jonas, 2009, p. 047/6) adopted a variation of this mapping, swapping the *for* and the *about* category.

strangers to navigating both internal and external references and know the challenge of satisfying, say, internal creative desires as well as external resource limitations, regulatory constraints and commercial expectations. A common strategy is to neglect internal references in favour of external ones or vice versa. Navigating by both internal and external references, however, may be exceedingly difficult.

Recognising that enquiry extends in time offers a way out. It allows shifting modes of justification away from atemporal results in, say, statistical or logical terms (as they are encountered in research as reported) towards narratives that demonstrate increasingly viable processes of acting and understanding (as they are encountered in design as done – see Glanville, 2019, pp. 46ff.).⁶ It also allows concatenating and nesting multiple modes of enquiry within the same body of work, as will be described in the following section.

Applying the theory

The primary mode of design PhD research should be chosen, I suggest, in accordance with the PhD student's personal disposition towards one of the three evaluation criteria – utility, meaningfulness, and predictability. Methodological choices between pragmatist, idealist and empiricist paradigms will fall into place according to Figure 1. Where predictability and, therefore, an empiricist mode is chosen, defence by standards of empirical science is possible and necessary. Where utility or meaningfulness is chosen, but examinations by conventional scientific (empiricist) standards must be expected, enquiries can be nested within and examined from overarching or subsequent empiricist perspectives.

Prior to the discussion of related strategic choices, some notes on the relationship between design and the criteria of empirical science, in particular those of reproducibility (i.e. predictability) and observability, are necessary. Conversational processes towards the previously unknown are, by definition, not determinable. That is,

⁶ At some point during my PhD research with Ranulph Glanville, I remarked on the challenge of fitting the entirety of my PhD research into a thesis. The gist of his response was: "When you are sent to get a medical check-up, the report will essentially state whether you're fit or not and why – without going into the details of everything the doctor did to come to that result."

they are not reliably predictable or reproducible. It makes little sense, for example, to expect two designers to respond to the same brief in the same way and with the same outcomes or to expect the same designer to design the same thing multiple times – expectations that would seem reasonable when raised analogously towards other occupations such as accountants, nurses or engineers. Already in the 1950s, Wiener likened attempts to predict moments of creative insight to attempts to predict “the particular house in the village which would next be struck by lightning” (Wiener, 1993, p. 25). In this aspect, expectations of “reliability” and “robustness” in design research are likely misplaced. Spontaneity is opposed to reproducibility (and insofar to generalisability). Those relying on empirical methods for the sake of academic defensibility are therefore well advised to attend to aspects of design that remain largely unaffected by the spontaneity of creative insight.

The design process is furthermore limited with regard to observability, a fundamental assumption of empiricism (Fischer, 2008). In the design-conversational cycle shown in Figure 3, the upper arc labelled “acting” represents the expressive and intervening output by which self affects the other, such as expressive activities (sketching, model making, verbal and written articulations, etc.). The lower “understanding” arc represents the sensory input and cognitive activities of understanding (perception, inspiration, confusion, etc.) by which the other affects the self. While the “acting” arc is largely observable, the “understanding” arc is not, as noted by Pask (1971, p. 77). Cross (1977), accordingly, separates design activity into “hackwork” (“acting”) and “magic” (“understanding”). Lawson points out that “[c]onducting empirical work on the design process is notoriously difficult. The design process, by definition, takes place inside our heads” (Lawson, 2005, p. 41], and, as von Glasersfeld notes, one “can never really know what goes on in somebody else’s head” (Pörksen, 2004, p. 40). Those relying on empirical methods for the sake of academic defensibility are therefore well advised to attend to observable aspects of design.

Four dispositions for design enquiry

1)-Observer inside, looking outwards: research through design

The observer being inside, looking outwards corresponds to involved transcendence of what has been established previously, and hence with research through design. This is depicted above in Figure 3. Investigators operate within their design enquiries – which entail, and may invite, error or failure – pursuing goals (meaningful resolutions of design challenges) that lie beyond these enquiries (thus potentially transcending what was previously known). In the absence of formal standards by which the attainment of these goals may be judged objectively, design research conducted in this mode tends to be difficult to defend vis-à-vis formal academic scrutiny. External approval of outcomes of this mode depends on designers' externalisation of their own criteria and standards to hopefully convince others (reviewers, examiners) that an adequate degree of rigour was in effect. In other words, it depends on new shared meaning. Where this mode of justification is not entertained or unlikely to be successful, a path to defensibility may be found by concatenating/nesting this mode of enquiry within research about/into design enquiry, as described in the following sections.

2)-Observer outside, looking outwards: research about/into design

The observer being outside, looking outwards corresponds to distanced, objective inspection, and thus to empirical scientific research about/into design. With this disposition, investigators identify (be it based on interest or need, or on literature review or prior research work) particular and worthwhile matters of interest pertaining to the design process and formulate testable and falsifiable hypotheses about them. Where no suitable data sets are available to test given hypotheses, investigators may identify or devise suitable means to test the hypotheses, and carry these tests out accordingly, be it in the field, in controlled laboratory settings, or somewhere in between.⁷ Taking this approach, investigators assume positions external to the design processes of interest to allow these processes to unfold with hopefully minimal bias. Observations made of design processes are captured in suitable quantitative and/or

⁷ More controlled environments are preferable with regards to the criterion *ceteris paribus*, while observations made in less controlled environments can be more naturalistic.

qualitative formats. Thus established, data sets are analysed to identify causal patterns which may or may not support the hypothesis at suitable degrees of reliability. Predictions regarding design processes not (yet) observed based on these causal patterns are considered justifiable according to the degrees of reliability achieved – typically by way of observing multiple design processes. This process is captured in Figure 4.

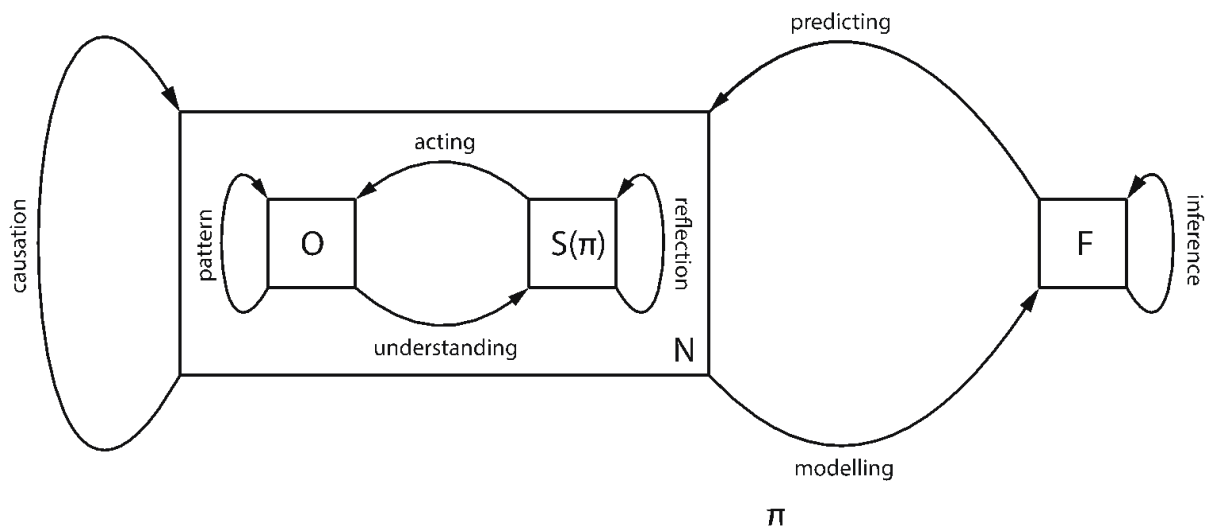


Figure 4. (Outer) research about/into (inner) research through design.

The inner, investigated research through design process(es) may be conducted by one or more designers other than the investigator(s) researching into it from the outer research process. Or, both processes can be conducted by the same investigator(s), be it consecutively or in parallel. In the sequential case, the investigator(s) may first conduct the research through design process(es) and then “turn around” or “step back” to approach that research through design activity as an observable natural system, for example, by referring to records of this activity (tracks left by it) as a data set to analyse, in separate research into/about enquiry. Findings derived in this empirical manner are, as indicated in the epistemological triangle, evaluated by the criterion of formal correspondence, i.e., the match between description and described, rather than by subjective judgement. They find acceptance where robust relationships between description and described stand up to scrutiny based on external scientific criteria.

3)-Observer outside, looking inwards: research for design

The observer being outside, looking inwards aims at developing and providing enabling resources (such as new guidelines, tools, methods, materials, etc.) to be applied in the context of subsequent designing: research for design. This process is captured with the inner (nested) cascade of two enquiries shown in Figure 5, the upper (enabling resource-generating) of which may be carried out in accordance with Figure 2 or in accordance with Figure 3.

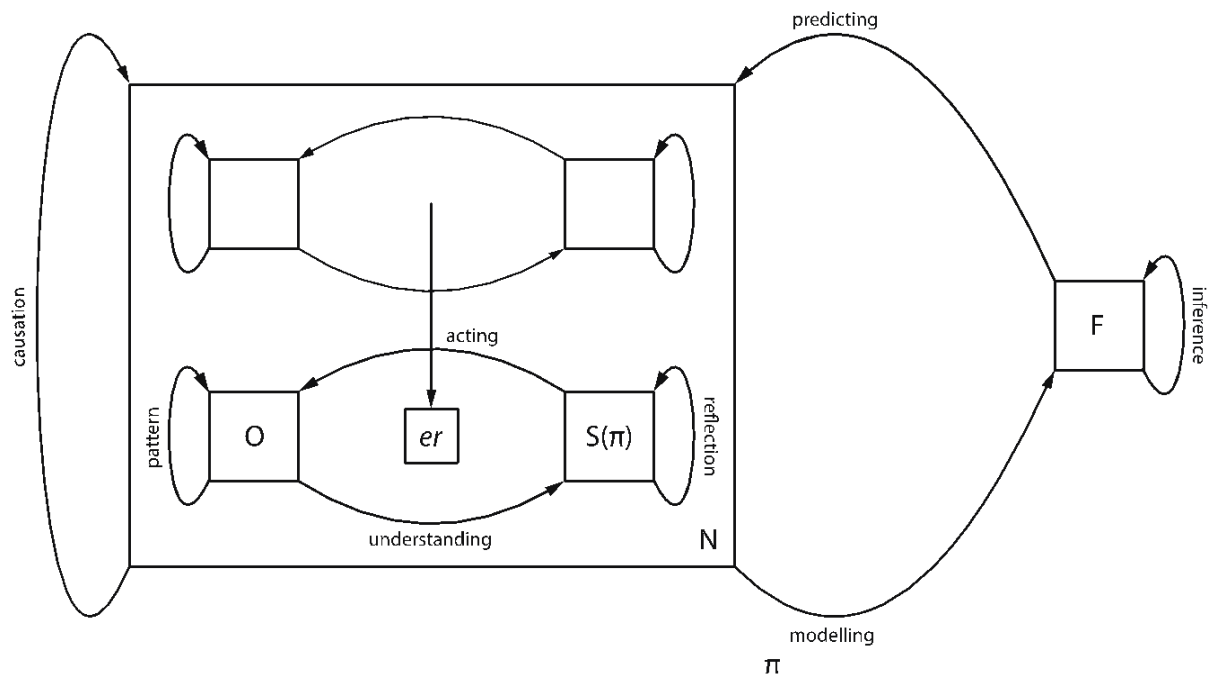


Figure 5. (Outer) research about/into (inner) research for design.

Researchers-for-design may develop enabling resources for particular design projects of their own. This makes them competent judges of the resources' utility but may not satisfy broader, more "objective" scrutiny that might be deemed desirable in some settings, such as academic examinations. This is especially the case when the resources in question are not convincingly innovative, or their utility is not entirely obvious to others. Alternatively, researchers-for-design may develop resources to enable design more generally, beyond the scope of their own design practice. Enabling resources

produced may be passed on to other design processes, to be applied and evaluated within those contexts. Both research for design as well as the evaluation of its success may require the study of multiple design processes that are to be enabled. This approach likely involves making decisions and embodying these decisions in enabling resources to empower others who have the responsibility to make those decisions within the scopes of their particular enquiries. In this way, enabling resources may have unduly restraining effects (see Fischer and Herr, 2007).

Outcomes of research-for-design are, as indicated in the epistemological triangle, subject to the criterion of utility within the context of subsequent design application. Dependent on subjective judgement and particular circumstances, these outcomes may not be robust when faced with formal, objective scrutiny. Where such robustness is desired, research for design and the application of enabling resources so generated may be nested within research about/into design, as indicated in Figure 5. In this approach, the enquiry that generates the enabling resource *er*, and the design enquiry enabled by the *er* are taken as the “natural system” N in a third research about/into design enquiry. This concatenation and nesting of three distinct enquiries can be resource-demanding but may be justified by the benefit of formal defensibility.

4)-Observer inside, looking inwards: research as design

The observer being inside, looking inwards corresponds to the investigator operating within her enquiry according to references (criteria, goals) of her own, as shown in Figure 6. Chow and Jonas (2009, p. 047/6) refer to this mode as research as design. It is the perspective from which the remaining (Frayling's) three categories of design research are navigated, chosen, nested and concatenated. In other words, this is the vantage point from which design researchers make over-arching strategic and methodological choices. Internal criteria for choices made from this perspective are, according to Glanville [22] as well as Chow and Jonas (2009), a matter of internal affairs and may include delight (Glanville, 2014a, p. 8) and the increase in numbers of choices available (von Foerster, 2003, p. 282).

Design research conducted in this mode is in accord with Glanville's positioning of scientific research as one restricted subset of the more general human activity of

designing. As a reversal of the commonplace academic conception of design as a subset of science, this mode requires taking careful and explicit measures to achieve robustness in the face of scrutiny, including, possibly, the use of scientific method in nested sub-enquiries to demonstrate mastery of that approach, the internalisation of external references, and the compelling enough expression of internal references. This mode may not be welcome in all places, and cybernetic design researchers engaging in this mode of enquiry would be well advised to proceed with both care and dedication to help establish it further.

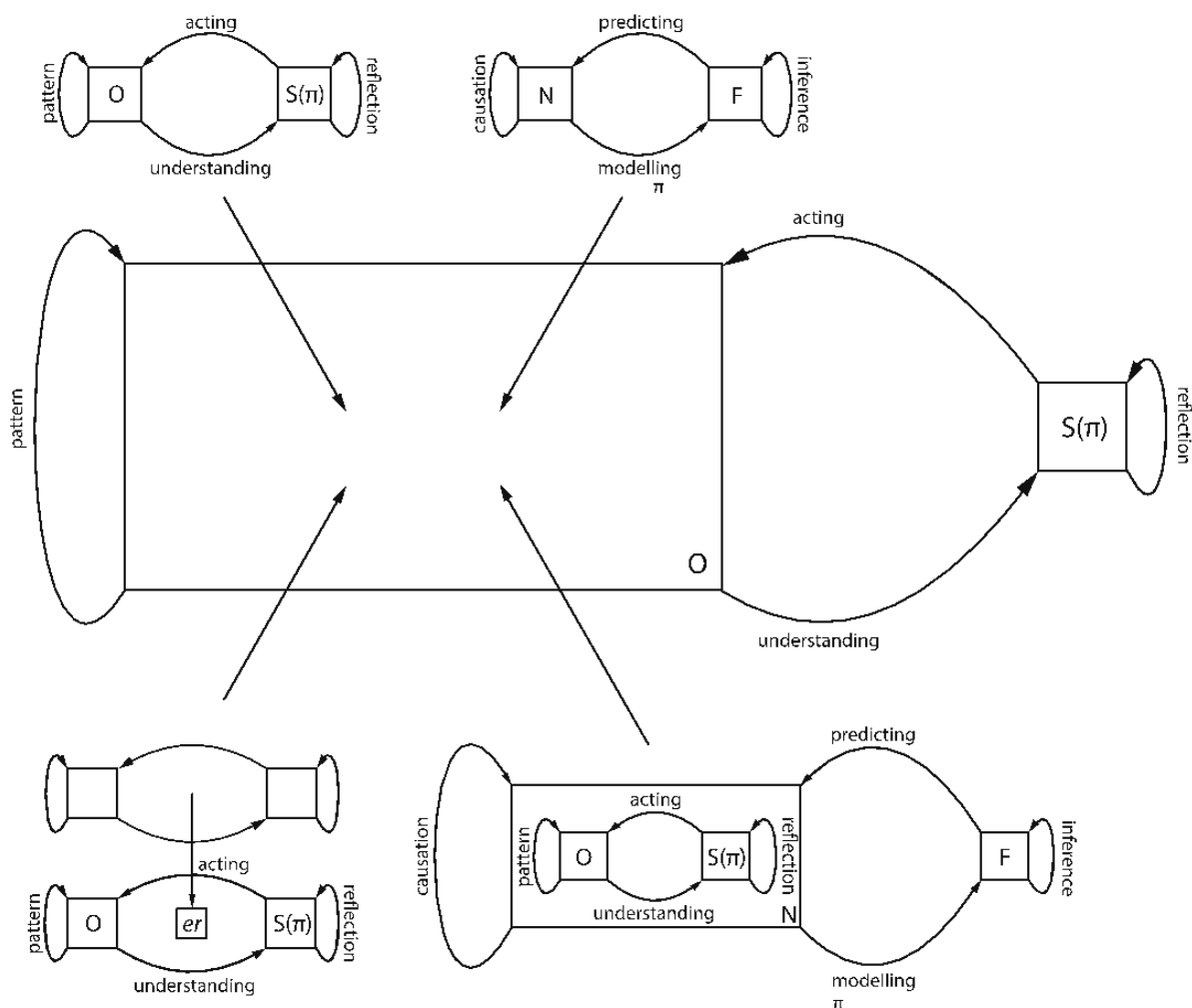


Figure 6. Research as design, deploying other modes of design research as needed.

Concluding remarks

The theory for enquiry developed here is offered to hopefully be of value in postgraduate and PhD-level design research and supervision. It suggests a number of ways in which design and scientific research may be concatenated and nested so as to satisfy both internal creative rigour and external formal scrutiny. These were developed diagrammatically on the basis of the epistemological triangle as described by Umpleby, Rosen's modelling relation as well as Glanville's four observer dispositions, and associated modes of research proposed by Frayling and Jonas. Several possible concatenations and nestings were discussed to hopefully inform enquiries with idealist, empiricist, and pragmatist agendas and their associated overarching evaluation criteria meaningfulness, predictability and utility.

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